THE TREND OF NATIONAL INTELLIGENCE*

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I HAVE during my lifetime had a great deal to do with the selection of children at 11 or 12 years of age for higher forms of education, and a good deal to do with the further selection which goes on at about 17 for entry to universities and colleges. I have however been very much worried by the fact that this process has an undesired and undesirable effect. It is intended, in all good faith, to be for the good both of the individual and the community, for it endeavours to educate each child in the way most likely to suit his ability and talents, and therefore most likely to make him happy, and this is also the way most likely to enable those talents to be of use to the community.

The Educational Sieve

But actually it has also another and regrettable result, especially in the case of the girls. The children chosen at 11 or 12 to enter on a longer and more difficult course of education are likely, on the average, to marry later (if at all) and to have fewer children (if any) than those who are not chosen. This is still more the case with those chosen later to enter colleges and universities. The men will marry later than they otherwise would have done, and a large proportion of the women will not marry at all. In short, the educational system of the country acts as a sieve to sift out the more intelligent and destroy their posterity. It is a selection which ensures that their like shall not endure.

It is clear that we nevertheless cannot do away with this selection of the most intelligent for the highest kind of education. It would indeed go on in some measure even were all our machinery of tests and examinations and interviews to be abolished. Somehow we must try to make social changes which will remove the influences causing more highly educated people to marry late and have few children. They are not greatly deterred from having children, I think, by any fear of having *themselves* to give up some material luxuries. They are somewhat deterred by the fear that a family of children will take away time and energy from their scholarly or scientific occupations. In the case of women they may indeed know that they will not as mothers and wives be able or even allowed to continue these occupations. Most of all, however, they are deterred by the fear of not being able to educate a large number of children well.

My interest in the quantitative connection between intelligence and fertility dates from 1921, when I tested a large number of Northumberland children and noted facts which seemed to suggest such an association. Since then, usually in conjunction with colleagues or students working under my guidance or in collaboration with me, I have made several experimental inquiries planned to elucidate this problem.

Intelligence and Size of Family

My general conviction is that there is a negative correlation between the "intelligence" of a child of about eleven years, and the size of the family of which he or she is a member, and I am fairly sure that the correlation coefficient is approximately −0·25. Of its cause I am much less certain, but I think it is largely due to the later marriages of intelligent people, their restraint in producing fewer children, and the inheritance of their intelligence by their offspring.

Caution is necessary because it is very difficult to disentangle, in the estimate of a child's "intelligence," that part which is his inborn potential intelligence, and that due to his education, his home, his environmental chances. I do not myself think that environment and social inheritance explain more than a fraction, at most half, of the

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negative correlation actually observed, but it is difficult to test this. I shall describe below some attempts I have made to do so. First however let me expand my statement that (whatever may be its cause) there is a negative correlation of about —0·25 between intelligence as measured by an intelligence test and the size of the family to which the tested child belongs.

This is not a fact obvious to casual notice. Indeed the man on the street will usually, in my experience, deny it and vigorously proclaim the many advantages, even the intellectual advantages, of belonging to a large family. An inverse correlation of —0·25 between size of family and intelligence leaves however plenty of room for cases where large families are intelligent and small families dull. It only implies that about 60 per cent of the families are in agreement with the tendency, leaving about 40 per cent of cases of discrepancy. No less than 20 per cent of the families, in spite of the prevailing tendency, would be above the average both in size and in intelligence, and 20 per cent would be below the average in both.

If we construct a grid or chequerboard table, showing along its one edge the size of family, and along the other edge the grade of intelligence of the child who is tested, then although the column of the largest families will show many with low intelligence, it will show some with high intelligence, though not so many; and vice versa, some members of small families will be stupid, though more will be clever. There are therefore plenty of exceptions to the general tendency.

Casual observers moreover, and even people like teachers, or journalists, or clergymen, do not see the whole population, but only a selected part of it. They know secondary school children, or slum children. Their acquaintances tend to belong to a class with large (or with small) families, tend to belong to a certain occupational or social stratum, and so on. That is to say, they are unacquainted with the whole of the data. Suppose we take such a part, where all the families are below average in size and above average in intelligence. That is the part of the data, for example, which will represent the relations, friends, and acquaintances of most of my hearers to-day. If we calculate the correlation between size of family and intelligence using only such a truncated grid, we find that it is, in this or any restricted sample of the population, so low as to escape casual notice entirely. Such selection always hides differences. But in a sample of the complete population, taken from slum and from suburb, from clerical and from manual occupations, from town and country, the negative correlation is unmistakable.

An Early Experiment

My earliest experimental approaches to our problem were indirect, and showed a negative correlation between the tested child's intelligence and the status of the father's occupation on a scale such as the Taussig. Since it was known that there existed a differential fertility among occupational groups, a negative correlation between the child's intelligence and the number of his sibs could be anticipated. In the years 1925-6 I planned a direct attack on the problem and was assisted by my student Dr. H. E. G. Sutherland. Our subjects were about 2,000 elementary school children (two nearly complete age-groups) in the Isle of Wight, about 400 boys of the Royal Grammar School, Newcastle-upon-Tyne, about 400 pupils of Moray House Demonstration School, Edinburgh, and 30 boys from Ryde Grammar School in the Isle of Wight. The size of family was ascertained by enquiry from the child tested. Only living children will, therefore, as a rule, be included.

Taking the elementary school children first, the percentage above average intelligence sank steadily, and with only one reversal, from 66 per cent among the only children, to 39 per cent among those belonging to a family of over seven. The percentages, as the size of family increased, were 66, 64, 56, 54, 49, 41, 34, 39. The data from the grammar and the demonstration schools were not in discord with this

general result, but, owing no doubt to being already selected samples, gave in themselves much lower correlations.

The chief blemishes in this research were (i) the use of group tests, which are more diluted by acquired verbal facility, especially reading ability, and (ii) the difficulty of the (possibly) unfinished families. This second difficulty however probably leads to an underestimation of the correlation. For if a child of eleven years is one of a small family it is probable that no more children will be born. But if he is a member of a large family it may be still further increased —though clearly much depends on his place in the family. Since the large families in this research are therefore more likely to be unfinished than are the small families, the negative correlations found are more likely to be underestimates than overestimates.

A Socially Homogeneous Group

We were chiefly concerned to test the possible explanation that the phenomenon of negative correlation is due to family circumstances and not to inheritance. Dr. Sutherland and I next therefore measured this correlation in a socially very homogeneous group, namely coal-miners working "at the face." The fathers of this group all belonged to the rank and file of coal hewers, everyone holding any kind of a distinguishing position, even of the lowest grade, being excluded. In 1926, 60,000 school children between the ages of 11 and 13, forming two age-groups attending elementary schools in the West Riding of Yorkshire, were given a group test of intelligence and were asked about their father's occupation and the number of their brothers and sisters. In 3,096 cases the father was a coal-miner. The correlations obtained were, in spite of the very homogeneous home conditions, still significantly negative.

Fatherless Children

It next occurred to me that I might obtain further insight into the problem if I took a group of fatherless children, in whose case the size of family was at least in part accidental, due to the father's death. I found in 1930 in Edinburgh 123 children born in 1916 or 1917 whose fathers had fallen in war before these children were a year old. Dr. Sutherland gave a group intelligence test to these, and also to a control group of 116 children with living parents, each child being matched by one of the same sex, same size of family, same age and same school—as far as this proved possible. The correlation of intelligence with size of family was in the fatherless group —0·19, in the control group —0·26. The difference is however not statistically significant; the numbers were too few.

If the sole cause of the usual negative correlation were the foresight shown by intelligent parents, and if in our particular group of 123 children the size of family were entirely an accident, one would expect no negative correlation in this group. As it is, though the correlation is smaller (i.e. nearer zero) compared with the control group, the diminution is not statistically significant. This experiment therefore fails to give conclusive support to the explanation of heredity though it points in that direction. And we must remember that even in the case of these fatherless children the intelligence of the parents may have influenced the number and the spacing of the children up to the time of the father's death, and produced the negative correlation found.

At the same time we searched our Yorkshire data and collected 724 fatherless children (though not in these cases necessarily fatherless from birth) and a control group of 581 with living parents. The correlations between size of family and intelligence were practically the same as in the Edinburgh groups, i.e. the fatherless children showed a smaller, but not significantly smaller, negative correlation.

Shepherd Dawson's Data

After 1931 for several years I engaged in no further researches on this question, but then Dr. R. R. Rusk, of the Scottish Council for Research in Education, called my attention to data left by the late Dr. Shepherd Dawson and suggested that one of my students might work it over. This was

done by Gerard S. A. O'Hanlon. Over 1,200 children between the ages of 5 and 8 years, whose parents were moving from a slum to a new housing area, had been given an individual Binet intelligence test. From these 1,239 cases Dawson had found a correlation of —0·19. After some years they were retested, by which time the number still traceable was only 293 and it is these which form the subject of O'Hanlon's paper. Other information, in addition to the size of family, included room space, nutrition, income, mother's age at marriage, and years married when this child was born. The raw correlation between I.Q. and size of family (total number of births) was —0·207. When, by the mathematical device of partial correlation, it was estimated what this correlation of —0·207 would be in a group homogeneous in all the other factors mentioned above (room space, nutrition, etc.) the value found was —0·293, that is, the correlation was even more pronounced.

It will be noted that in this research the test used was an individual Binet test. It is therefore less open to the criticism that education, and not native intelligence, is being measured.

If we use these results, and similar results from other workers, as data from which to estimate whether the intellectual average of our race is sinking from generation to generation, an important point to remember is that in all the experiments quoted so far the families have been ascertained through a child of the family, and therefore childless marriages are omitted entirely. Nor are those potential parents who have not married included in the sample. It seems possible and indeed somewhat probable that these members of a generation—the childless—are, on the average, of rather high intelligence (consider, for example, the large band of unmarried women teachers). If the tendency is for intelligence to rise as we go from large families to those with few children, with two children, with one child, it seems very possible that it will continue to families with no children; that is to say, that the unborn children of the unmarried and the childless would have been, on the average, yet more intelligent (though we must remember that the childless group of adults, unlike the groups of parents ascertained through one of their offspring, will contain adults incapable of being parents). If this is so, then a negative correlation of —0·25 does not fully indicate the strength of the forces tending towards a deterioration of intelligence generation by generation. It is true that in a very important research Fraser-Roberts, R. M. Norman, and Ruth Griffiths found "only" children a little less intelligent than children with one sib, but they attribute this largely to the fact that illegitimate children were usually returned as only children. They felt sure that the decrease in average intelligence with size of family was really linear. They are further of the opinion that almost all sources of bias or of error, especially sampling error, would lead to estimates of the negative correlation that would be too low.

The Bath Experiment

Their article is in my opinion the best that has been written on this subject because of the completeness of the sampling and the excellence of the statistical work. My samples were in several cases fairly complete age-groups; but theirs can be said to be practically quite complete, all children (except a mere handful) whose homes were in Bath and whose birthdays were between September 1st, 1921, and August 31st, 1925, being ascertained, 3,401 in number, of whom 3,362 were actually tested, most of the missing 39 children having meanwhile left Bath and some having died. The Advanced Otis group test was used, but 1,271 of the children had also been given an individual Binet test, so that a check was possible. The Binet I.Q. indeed "showed a significantly higher association with sib number than did Otis I.B." There was thus "no suggestion that the verbal group test gave too high an estimate because of a possible social bias."

The statistical procedures adopted were excellent—they were discussed by the authors with Professor R. A. Fisher—and the conclusions are conservative. The corre-

lation coefficient in which we are interested here was —0·224 (living children only included in the family size).

It is clear that if there is a negative correlation between size of family and intelligence, and if the conditions causing this are allowed to continue, then the average intelligence will sink generation by generation. There is indeed some direct evidence that this is so, for example E. O. Lewis's investigation. Various calculations have been made based on correlations such as I have to-day discussed, calculations which do not ask whether the cause is to be sought in educational handicaps (which can be removed by legislation) or in genetic changes, but estimate the difference in intelligence quotient between a parental and a filial generation due to all causes. These calculations show an alarming decline of at least two points of Binet I.Q. per generation, and probably more.

The first such calculation, made by a method arithmetically somewhat similar to that about to be described, was, as far as I have been able to ascertain, published in the *Journal of Educational Psychology* for 1927, by Lentz, who divided each group of children by the number in the family, to obtain a distribution representing the parental generation. But the assumptions on which he apparently based his procedure were, it seems to me, erroneous, for they implied perfect correlation between parental and filial intelligence. In his book *The Fight for our National Intelligence* (1936) Raymond Cattell also uses the above method, and further estimates the distribution of intelligence in the next, as yet unborn, generation by *multiplying* each group of children by the number in the family, assuming in addition, it would seem, a perfect correlation between parental and filial fertility. However, both these assumptions of perfect correlation are unnecessary, and an arithmetical procedure identical with Cattell's second plan, but with other and much more reasonable assumptions, has to-day the support of Professor R. A. Fisher. I shall describe it in what I believe would be in effect his own words. It depends upon a comparison of the average I.Q. of *families* (counting each family once only) and the average I.Q. of all the *children* in these families. The former is an unbiased estimate of the average I.Q. of the parents, the latter an unbiased estimate of that of their children. The difference is the decline.

Indirect Calculation of the Decline

It is desirable I think to dwell for a while on this calculation, for it may seem at first sight to be performing the impossible, since it purports to estimate a decline in intelligence merely from tests administered to one generation. But first let me give an example, using the data from the Isle of Wight already referred to. There were in all 1,924 children tested, 840 in one year and 1,084 in another. The latter were a more nearly complete age-group and I shall confine the calculation to them. It is shown in Table I. Column (*a*) shows the number of children actually tested, and since only one year-group was concerned, this 1,084 is also the number of families. True, there may have been some twins among the 1,084, or some siblings born within a twelvemonth of one another, but such cases must be few. Column (*b*) gives the number of children in the family, including the tested child, and column (*c*) the average I.Q. of each group

TABLE I

AVERAGE I.Q. OF PARENTS AND CHILDREN IN 1,084 FAMILIES

(*a*) No. of families	(*b*) No. in family	(*c*) I.Q.	(*d*) Product *ac*	(*e*) No. of children	(*f*) Product *ce*
115	1	106·2	12,213·0	115	12,213·0
212	2	105·4	22,344·8	424	44,689·6
185	3	102·3	18,925·5	555	56,776·5
152	4	101·5	15,428·0	608	61,712·0
127	5	99·6	12,649·2	635	63,246·0
103	6	96·5	9,939·5	618	59,637·0
88	7	93·8	8,254·4	616	57,780·8
102	(8)*	95·8	9,771·6	816	78,172·8
1,084			109,526·0	4,387	434,227·7
			Mean=101·04		Mean=98·98

* Really "over 7." Using 8 will give a slightly underestimated figure for the decline.

Estimated average I.Q. of the parents ...	101·04
Estimated average I.Q. of all their children...	98·98
Decline ...	2·06

of children. In column (*d*) the average I.Q. of all these children is found to be 101·04.

This value is taken as the estimate of the average I.Q. of their parents, on the very reasonable assumption that the average I.Q. of all parents will be the same as the average I.Q. of all their children *if they each have the same number of children*. Here each family is represented by one child, not specially selected, and therefore representative.

There is no assumption about the value of the correlation coefficient of parental intelligence with filial intelligence. This would have to be known if an estimate were required of the intelligence of the parents of *any specified size* of family, for in that case the phenomenon of regression, which is dependent upon the degree of correlation, would have to be taken into account. But when the average I.Q. of all the parents is estimated, regression plays no part. I have to thank Dr. D. N. Lawley for clearing up this point for me in discussions.

To return to our table: column (*e*) shows the total number of children of those parents, obtained by multiplying together columns (*a*) and (*b*). Then the average I.Q. of all these 4,387 children is obtained by multiplying the I.Q.'s of column (*c*) by the numbers in column (*e*), adding, and dividing by 4,387 as is shown in the last column. The assumption is again made here that the one child tested in a family is a fair sample of that family, and his I.Q. an unbiased estimate of the average I.Q. of the family. The child tested is in no way specially selected, and is equally likely to be above or below his brethren in intelligence.

The results of such calculations, of which a number have been reported, are remarkably in agreement, and with few exceptions give values for the decline in intelligence ranging from slightly below 2 points to well over 3 points per generation. The most widely known are those on the data of Dr. Raymond Cattell, gathered in Leicester, and on the data of Dr. Fraser-Roberts and his co-workers, gathered in Bath. These agree more closely than I at one time thought. The decline given by Cattell on page 42 of his book *The Fight for our National Intelligence* is 3·1 points of the units of his test; but I deduce from his diagram on page 269 of his article in the *British Journal of Psychology* for January 1936 that the standard deviation of these units was about 21, so that in Binet units his 3·1 would become about 2·3 points of decline. The Fraser-Roberts data give a decline in Otis units of 4·14 points, estimated by Fisher to be equivalent to 2·04 Binet units. These estimates make no allowance for the existence of individuals in the parental generation who were childless, and are therefore probably underestimates. Further, they do not seem to make any allowance for the fact—and I think it is a fact—that the number of years between generations is smaller for the class of parents who have large families, and larger for the parents of small families. If this is so, the values are again underestimates.

On the other hand, these estimates lump together all the possible causes which may have created the negative correlation between size of family and intelligence, and assume that these causes will continue to operate, whether they are social, and remediable by social and environmental change, or are genetic, and remediable only by selection. We however are very interested to know *whether* the causes are environmental or genetic. It was towards elucidating this that I planned my experiment with the children fatherless from birth.

The distinction between the two categories of cause is not sharp, for the adverse genetic selection which we fear to be going on is itself due to the social environment, at least in part. But a clear distinction can be drawn between an explanation which attributes the lower intelligence of large families to biological inheritance from their parents, and an explanation which asserts that their lower scores are directly due to the largeness of the family, due for example to the overcrowded home with no opportunity for study, due to the greater poverty when the wage has to support more children, due to the fewer books, the slummier district, the less well-staffed school in such a place.

The kind of social reform which the second

class of explanation would call for may differ from the kind of social reform which would be needed to reverse the deterioration due to actual selection for poor mental inheritance. A flat rate of family allowance, for example, might make matters better environmentally, while further increasing the adverse selection.

Heredity or Environment?

Much therefore depends on the answer to the question how much of the scatter of intelligence in our population is due to inheritance, and how much to differences in schooling and education. About this there has long raged acute controversy, which has recently flared up again in America, after a period during which it was generally agreed that from 50 to 80 per cent of the scatter was due to heredity. That fairly quiescent period followed the appearance of the *27th Yearbook of the (American) National Society for the Study of Education*, which was devoted to this problem and contained papers which, while conflicting, did so on the whole only within the above limits.

In 1940 however there appeared the 39th Yearbook of that society, among the articles in which there is much greater disagreement, between (one might say) a Californian school headed by Lewis Terman and the late Barbara Burks, claiming a very large influence for heredity, and an Iowa school, headed by George Stoddard and Beth Wellman, denying this and making big claims for schooling. Among the kinds of research which are used in attempts to distinguish between nature and nurture are correlations between intelligence scores of identical twins, between foster children and foster parents, foster children and true parents, children brought up in a homogeneous environment like an institution, and so on. The Iowa school base their conclusions mainly on large increases in I.Q. following nursery school and infant school education, which are not confirmed by other investigators, and are criticized as being either due to the inaccuracy and overhigh standard of baby tests, or to selection and statistical errors in the treatment of the resulting data. The differences of opinion are honest, and although I for my part think that the Iowa researches are unreliable, it is clear that we are far from being sure.

Of the 2 or 3 points of decline of I.Q. per generation which the differential birth-rate data indicate, we are therefore unable to say with confidence how much is due to heredity and how much to environment. When, in a memorandum to the Royal Commission, I said that I feared the decline was one point, I meant one point due to heredity and to selection. It may well be more, but I hardly think it can be less. Particularly emphatic seems to me the fact that while the correlation between the intelligence test scores of siblings is about ·5, that between all twins is about ·7, and between twins after removal of all pairs where sex, bloodgroup, or other criterion indicates a double conception, this correlation rises to about ·9. This last rise in particular seems inexplicable except by a genetic explanation, and suggests that a considerable part of what we call intelligence is inherited. Its genetic background is probably complex and in all probability a large number of genes are concerned.

That the mode of inheritance of intelligence is important in considering this matter has been illustrated by Professor J. B. S. Haldane by the analogy of the "ever-sporting" strain of stock. Since about Queen Elizabeth's time "double" stocks have been known, the doubleness, which is recessive, being due to a Mendelian gene (or perhaps a pair).

The doubleness is due to all the sexual organs of the flower becoming petals, and so double flowers are entirely sterile. The single flowers, in the ordinary strain, are either pure singles, which have only single offspring, or hybrid singles, which throw some doubles. In the ordinary strain therefore the proportion of doubles grows less and less as the generations follow one another —as we fear intelligence will grow less and less in human beings.

But in the "ever-sporting" strain, each generation is composed of approximately half singles and half doubles. Though the

doubles are sterile, the singles of a generation always produce offspring who are in half the cases doubles. If mankind were like this, and intelligent people (double flowers) were quite sterile, still unintelligent people (single flowers) might produce a full quota of the intelligent, generation after generation.

I am afraid however that mankind is not like this. We are not divided sharply into intelligent and unintelligent, as stocks into doubles and singles. Intelligence ranges gradually, step by step, from genius, through the average man, down to the defective, and the distribution is approximately normal or gaussian, and is therefore probably due not to one but to many genes. The explanation of the ever-sporting phenomenon in stocks is that the " singleness " gene, in that strain, is lethal to pollen grains, and so all the surviving pollen bears the doubleness gene. Some human genes concerned with intelligence may possibly act like the gene causing singleness in stocks—which would slow down the drop in I.Q. per generation. But it is surely unlikely that many do, indeed I think it unlikely that *any* do.

However that may be, and whether the decline calculated from the differential birth rate be genetic or environmental, it is in either case a serious matter for the nation. If the lower intelligence of the members of large families is an educational result due to the overcrowding and poverty of the home, it could, with goodwill and suitable legislation, perhaps be cured in half a century. If it is genetic and inherited, a longer time will be needed to restore the loss, if indeed it can be restored, for although social conditions may alter so as to equalize the birth rate over the range of intelligence, it would be necessary to do more than this, it would be necessary to create a differential birth rate in the opposite direction, in order to recover what has been lost.

Need for a Direct Experiment

It is comparatively easy to obtain support for the kind of reform needed to equalize the cultural and educational handicaps of large versus small families. Some of these reforms might also assist in equalizing the birth rate, though others, however desirable for other reasons, might even accentuate it. It is much more difficult to obtain support for reforms tending to eugenic progress, partly because the man in the street thinks them impracticable, but largely because he does not believe in the alleged decline in intelligence. He is very sceptical about conclusions concerning the difference of intelligence between two generations when these conclusions are based entirely on measurements made on only one generation. He demands a straightforward measurement of two succeeding generations, and I sympathize. *Actual measurement of two successive generations is desirable, indeed essential, and I would urge all who are in a position to facilitate such an experiment, or to contribute towards carrying it out, to do so.*

Even when measurements on two successive generations are made however, there are still difficulties in the way of interpretation. The testees will probably be school children of about the age of eleven, because that age, before children have scattered into different kinds of secondary school, is the time when a large random sample can most readily be obtained. The sampling would have to be equally complete in both generations, if the pedant will allow me to qualify the word " complete." If, for example, defectives in special schools were included in the one case but excluded in the other that would queer the comparison. Then there is the effect of migration. There may have been an influx of children of a new type or a different race or social class into the district or country. Further, the children of the later generation may have become accustomed to intelligence tests, and be thus enabled by familiarity with the situation to score higher marks than their fathers did when children. These and others are real difficulties. They should not however deter us from making the experiment with such precautions as we can devise. The question awaiting a decisive answer is of such importance that it would be worth while to go to much trouble, and to spend money freely, in order to settle it. I hope that

this may be done in our time. If the decline is as rapid as Cattell fears, it should be detected (if the conditions can be equalized) in a period of even five years if a group of 50,000 children can be tested; and even if it is much less rapid, it should nevertheless be detected by an experiment on groups of 100,000 over fifteen years.

Factors of the Mind

I turn now to a different aspect of my subject. In the words of Karl Pearson, "Galton created the subject of correlation," and from correlation has arisen that branch of psychology in which I am most interested, and in which alone I can perhaps claim a certain measure of competence beyond the average—I mean the factorial analysis of human ability. I would like to devote a few minutes to explaining what it is, and how it may turn out to have a bearing on eugenics.

An intelligence quotient measures, more or less reliably, the powers of mind in a kind of linear fashion, as though all minds were alike except in the height of intelligence to which they can rise. But everyone knows that minds differ also in other ways, and that two persons with the same intelligence quotient may have nevertheless very different kinds of mind—the one man may be a poet and the other an engineer. Mathematically speaking, one might say that the mind has not one dimension but many, and that the I.Q. is only a sort of *volume* of the mind which does not give any indication of its *shape*. These dimensions or directions of the mind are the "factors" spoken of in factorial analysis, which is based on a table of a large number of correlations between different mental activities.

Before we can have correlations we must have quantitative measures of the qualities to be correlated, and these are provided by the scores in different kinds of tests, some logical in nature, some with mechanical apparatus, some with words and some without, some using geometrical figures, some numbers, some drawings of right and left hands to be identified quickly, some based on codes and cyphers, and so on, an apparent medley of all kinds of tests.

When a number of persons have been submitted to say three or four dozen of these diverse tests, which *a priori* appear likely to call upon different powers of the mind, correlations between the tests can be calculated. There will be a large number of such correlations which can most conveniently be entered in a square table with the names of the tests written both along the top edge and down the side. Certain regularities then become apparent, or can be discovered by suitable mathematical analysis.

In the first place, the correlations are mainly positive. Desirable qualities tend to be positively correlated in men. If we compare ability to supply the missing conjunctions in a piece of prose with the ability to say quickly whether the wheel in a mechanical model will turn this way or that when the lever is actuated, we find that these abilities apparently so different are positively correlated—perhaps not very highly correlated but still positively.

Clearly we can therefore attribute this tendency, if we like, to a general factor linking all mental activities, and British psychologists generally do so—the factor is Spearman's *g*. But it is not necessary to do so, and American psychologists, following the lead of L. L. Thurstone, for the most part do not use a general factor, but analyze the correlations immediately into group factors, as also the British psychologists must do with the residues of correlation left after the associating effect of the general factor has been removed.

The group factors are more or less the same to whatever school the factorial psychologist may belong. As the Americans at the moment have the lead in this work I shall in illustration mention some of the factors L. L. Thurstone and his co-workers claim to have isolated. The chief are a space factor, a perceptual factor, a number factor, and two different verbal factors. British psychologists also recognize a verbal factor, though they have not split it into two, and a "space" factor, believed to be much the same as a "practical" factor found by others.

A Possible Compensation ?

If it be true that there is going on a steady fall, generation by generation, in that intelligence which we measure or estimate by our present-day intelligence tests, may there not perhaps be compensation, it may be asked, in an increase in some other form of intelligence which may be more suited to the needs of the future. For example, is it possible that although verbal intelligence is decreasing, mechanical intelligence is increasing ? There is against this hope the fact that nearly all if not all correlations between mental tests are positive. This seems to make the hypothesis improbable, but it does not make it impossible, for it is conceivable that this fact too is changing, and that the selection which is going on generation by generation, owing to the differential birth rate, may land mankind in an epoch when what we now call intelligence is actually correlated negatively with what will then be called intelligence.

I do not myself share this view. I think that intelligence is much more one thing than such a view would suggest. It is true that in the adult it takes different forms, due mainly in my opinion to his education and the influence of the environment in which he passed his formative years, though possibly also due to inherited powers which mature only in adult life. But although intelligence expresses itself in different forms, in its highest aspects it is always concerned with abstractions and concepts and relationships. Practical intelligence, as it is called, is of considerable importance in the world : but theoretical intelligence is of immeasurably greater importance. The clever garage mechanic may improve a motor-car engine. The student of thermodynamics or of atomic physics is much more likely to make the motor-car engine obsolete and replace it by a more efficient engine. And such men think in abstractions, often clothed no doubt in symbols of some sort or another, symbols which may be verbal, or mathematical, or, like Faraday's tubes of force, more mundane and materialistic, but symbols nevertheless, the real values with which these minds are operating being abstract relationships. I think there is a power of thinking abstractly which we can recognize in some of our fellow men whether they be chemists or classics, artists or mathematicians, craftsmen or administrators ; and that though these men of high intelligence (as I shall call them) may, whether from education or heredity, possess different factors of the mind, they are alike in operating with them at a high level. This level is what I call intelligence, and it is, I fear, being steadily lost to Europeans by the selecting power of the differential birth rate, those who possess it tending to have fewer children than those who don't.